Theory & Computation

Enhancing the propagation of fast electron beam through the use of graded-resistivity guides.

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We observe an increase in the width of a collimating magnetic field, and higher resistive guide heating, where a graded-resistivity guide element was employed in order to collimate a relativistic electron beam. The electron beam is generated from the interaction of a Vulcan PetaWatt-like laser pulse with a solid target. Simulations performed using the three-dimensional hybrid-particle-in-cell code ZEPHYROS show that the resistive magnetic field extends over much of the guide element. This field deflects relativistic electrons into the guide which acts to smooth current density gradients. These smooth gradients limit the growth of magnetic fields within the guiding element, preventing electron beam filamentation, which is a problem with guides using a step change in resistivity. As a result, relativistic electron confinement improves, and simulations show increased heating at-depth, coupled with a reduction in temperature inhomogeneities.

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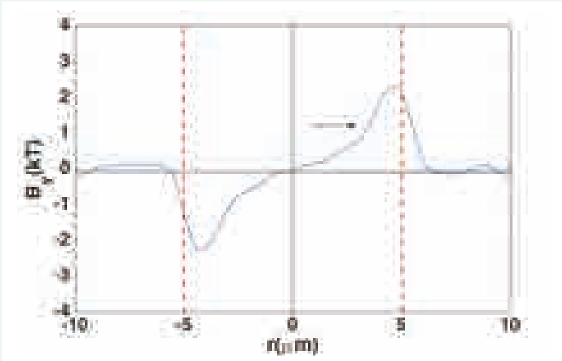

Cross-section of the magnetic field, B, as a function of radial position r at x=10 μm, taken at 2.2 ps and limited to -10 < r < 10 μm in y-midplane. The vertical dashed lines show the boundaries of the guide element. The arrow shows the gradient in the magnetic field inside the guide-element.

Modelling the effects of the radiation reaction force on the interaction of thin foils with ultra-intense laser fields

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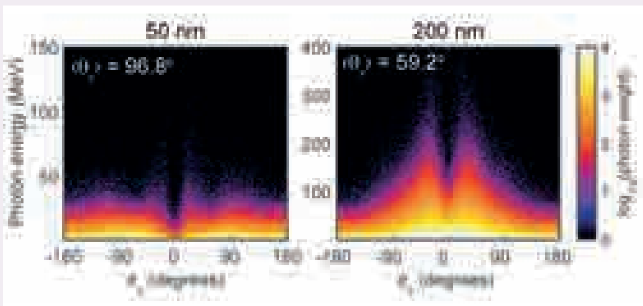
The effects of the radiation reaction (RR) force on thin foils undergoing radiation pressure acceleration (RPA) are investigated. Using QED-particle-in-cell simulations, the influence of the RR force on the collective electron dynamics within the target can be examined. The magnitude of the RR force is found to be strongly dependent on the target thickness, leading to effects that can be observed on a macroscopic scale, such as changes to the distribution of the emitted radiation and the target dynamics. This suggests that such parameters may be controlled in experiments at multi-PW laser facilities.



A plot of the photon angular distributions from a 50 nm (left) and a 200 nm (right) aluminium foil target. These distributions are compared at the time of maximum synchrotron emission, corresponding to 13 and 31 laser periods respectively.

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